Original Article

Long-Term Compliance with Salt Restriction in Japanese Hypertensive Patients

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The purpose of the present study was to investigate the long-term compliance with salt restriction in Japanese hypertensive patients. Subjects included 389 patients, 230 women and 159 men, mean age 58±11 years, who underwent successful 24-h home urine collection more than three times over an interval of a year. Urinary salt, potassium, and creatinine were measured. Additionally, family history, habitual alcohol intake, smoking habit, physical activities, and job status were assessed by use of a questionnaire. During the follow-up period (average 3.5 years), participants underwent urine collection 4.6 times in average. Urinary salt excretion at the last visit was significantly lower than that at the first visit (8.7±3.4 *vs.* 9.6±4.1 g/day; $p<0.01$). Urinary potassium excretion also decreased significantly during this period (from 2.0±0.7 to 1.9±0.7 g/day; $p<0.05$). Among the mean 4.6 urine collections, 45.2% (men 34.6%, women 52.6%) of the patients successfully achieved <6 g (100 mmol of sodium)/day of salt excretion on at least one occasion. The rate of achievement of averaged urinary salt excretion <6 g/day dropped to 10.3% (men 4.4%, women 14.3%). Only 2.3% (men 0.6%, women 3.5%) of the patients achieved <6 g/day on all occasions. There were no significant differences in age, habitual alcohol intake, smoking habit, physical activities, or job status between patients who complied with the salt-restricted diet and those who did not. Results suggest that long-term compliance with salt restriction is poor in Japanese hypertensive patients. Since no specifically defining characteristics were found in the compliant patients, repeated measurements of urinary salt excretion seem to be important to encourage salt restriction. (*Hypertens Res* 2005; 28: 953–957)

***Key Words*: salt restriction, 24-h home urine collection, urinary salt excretion, hypertensive patients, long-term compliance**

Introduction

Lifestyle factors, including dietary salt intake, play major roles in the onset and development of hypertension (*1–3*). Many observational studies have shown a positive relationship between salt intake and blood pressure (BP) (*4–6*), and salt restriction has been suggested to be effective as a non-pharmacological treatment of hypertension (*7–11*). The seventh report of the Joint National Committee (JNC 7) recommends sodium reduction to a level of no more than 100 mmol/day in hypertensive patients (*11*). On the other hand, salt intake has been reported to be high in the Japanese population (*12*). We have previously reported that an awareness of the importance of salt restriction is not associated with actual salt restriction in hypertensive outpatients (*13*). Since the average urinary salt excretion was 9.7±3.9 g/day in that study, achieving the level of salt restriction suggested by the guidelines would seem to be difficult in the Japanese population. Based on our previous observations, we investigated the long-term compliance with salt restriction in the present study.

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Table 1. Characteristics of the Subjects

	First visit	Last visit
Age (years)	58.2±11.0	61.7±10.9
Body weight (kg)	60.9±11.0	61.2±10.9
Systolic blood pressure (mmHg)	145±15	138±15**
Diastolic blood pressure (mmHg)	87±9	81±9**
Serum creatinine (mg/dl)	0.85±0.47	0.98±0.88**
Urinary salt excretion (g/day)	9.6±4.1	8.7±3.4**
Urinary potassium excretion (g/day)	2.0±0.7	1.9±0.7*
Urinary creatinine excretion (mg/day)	1,020±310	994±303**

Values are means±SD. *$p<0.05$, **$p<0.01$ *vs*. first visit.

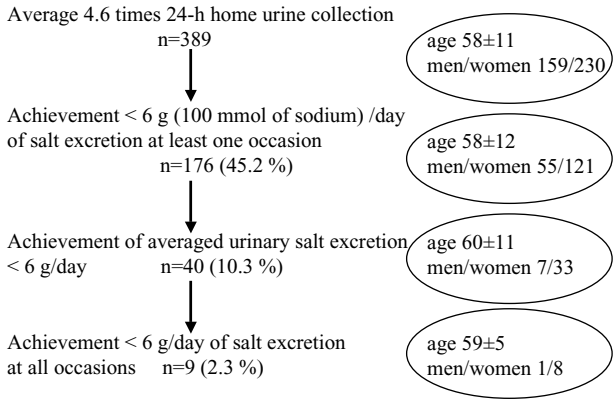

Fig. 1. *Compliance with salt restriction.*

Methods

Participants were recruited from hypertensive outpatients who visited the National Kyushu Medical Center. We undertook 24-h home urine collection in 1,567 outpatients between January 1998 and December 2004. Twenty four-hour urine samples were collected using a partition cup (proportional sampling method (*14*)), which collects a 1/50 portion of the 24-h urine. If the 24-h creatinine excretion was within ±30% of the estimated values, the urine collection was considered successful. Patients with malignant hypertension, secondary hypertension or diabetic nephropathy were excluded. Subjects included 389 patients, 230 women and 159 men, mean age 58±11 years, who underwent successful 24-h home urine collection more than three times over an interval of a year. Urinary salt, potassium, and creatinine were measured. BP was measured with a sphygmomanometer by the doctors while the patients were seated. Hypertension was considered to be present in patients with systolic BP (SBP) ≥140 mmHg and/or diastolic BP (DBP) ≥90 mmHg, or those patients on antihypertensive medication. At the first visit of the patients, family history, habitual alcohol intake, smoking habit, physical activities, and job status were assessed by use of a questionnaire. Then, the patients were advised to reduce their salt intake to the level of <7 g/day by trained dieticians. The protocol was explained in detail, and informed consent was obtained from each patient.

Statistical Analysis

Values are presented as the mean±SD. The differences in the variables were compared by one-way ANOVA. A χ^2 test was also utilized when appropriate. p values less than 0.05 were considered significant.

Results

During the average 3.5-year period of follow-up, participants underwent urine collection 4.6 times in average.

The characteristics of the subjects are shown in Table 1. The mean age was 58.2±11.0 years at the first visit and 61.7±10.9 years at the last visit. Mean BP at the last visit was significantly lower than that at the their first visit (138±15/81±9 *vs*. 145±15/87±9 mmHg; $p<0.01$). Serum creatinine at the last visit was significantly higher than that at the first visit (0.98±0.88 *vs*. 0.85±0.47 mg/dl; $p<0.01$). Urinary salt excretion at the last visit was significantly lower than that at the first visit (8.7±3.4 *vs*. 9.6±4.1 g/day; $p<0.01$). Urinary potassium excretion also decreased significantly during this period (from 2.0±0.7 to 1.9±0.7 g/day, $p<0.05$).

Figure 1 demonstrates the compliance with salt restriction. Among the mean 4.6 urine collections, 45.2% (men 34.6%, women 52.6%) of the patients successfully achieved <6 g (100 mmol of sodium)/day of salt excretion on at least one occasion. The rate of achievement of averaged urinary salt excretion <6 g/day dropped to 10.3% (men 4.4%, women 14.3%). Only 2.3% (men 0.6%, women 3.5%) of the patients achieved <6 g/day on at all occasions.

Comparisons of the characteristics between the patients who had average urinary salt excretion of less than 8 g/day (Low group, $n=137$) and those who had more than 8 g/day (High group, $n=252$) are presented in Table 2. Since urinary salt excretion was positively correlated with body weight, this analysis was conducted using urinary salt excretion values adjusted for body weight (per 60 kg body weight). Urinary salt excretion values at the last visit were significantly lower than those at the first visit in the High group (9.9±3.3 *vs*. 11.1±3.9 g/day; $p<0.01$), but in the Low group these values were not significantly different (6.6±2.5 *vs*. 6.8±2.8 g/day; n.s.). Mean BP at the last visit was significantly lower than that at the first visit in both groups. Urinary potassium excretions at both the first and last visits were significantly lower in the Low group, suggesting that salt restriction may be associated with low potassium intake. There were no significant differences between the two groups in any of the patient characteristics, including age, habitual alcohol intake, smoking habit, and physical activities.

In addition, the frequency of the subjects who were under

Table 2. Comparison of the Characteristics between Patients with Low and High Salt Excretions

	Urinary salt excretion	
	Low (average <8 g/day[#])	High (average ≥8 g/day[#])
Number of patients	137	252
Sex (men/women)	50/87	109/143
Age (years)	58.3±11.6	58.1±10.4
Body weight at the first visit (kg)	61.8±12.1	60.5±10.3
Body weight at the last visit (kg)	61.9±11.1	60.8±10.7
Systolic blood pressure at the first visit (mmHg)	146±16	145±15
Systolic blood pressure at the last visit (mmHg)	138±17**	138±13**
Diastolic blood pressure at the first visit (mmHg)	88±10	87±9
Diastolic blood pressure at the last visit (mmHg)	81±9**	81±10**
Urinary salt excretion at the first visit (g/day)	6.8±2.8	11.1±3.9††
Urinary salt excretion at the last visit (g/day)	6.6±2.5	9.9±3.3**,††
Urinary potassium excretion at the first visit (g/day)	1.9±0.7	2.0±0.7†
Urinary potassium excretion at the last visit (g/day)	1.8±0.7	1.9±0.7†
Urinary creatinine excretion at the first visit (g/day)	975±309	1,045±308†
Urinary creatinine excretion at the last visit (g/day)	967±324	1,008±290**
Habitual alcohol intake (%)	54.7	59.7
Smoking habit (%)	13.8	21.2
Physical activities (≥1–2/week,%)	57.3	49.1

Values are means±SD. **$p<0.01$ *vs*. first visit; †$p<0.05$, ††$p<0.01$ *vs*. Low. [#]Urinary salt excretion was adjusted for 60 kg of body weight.

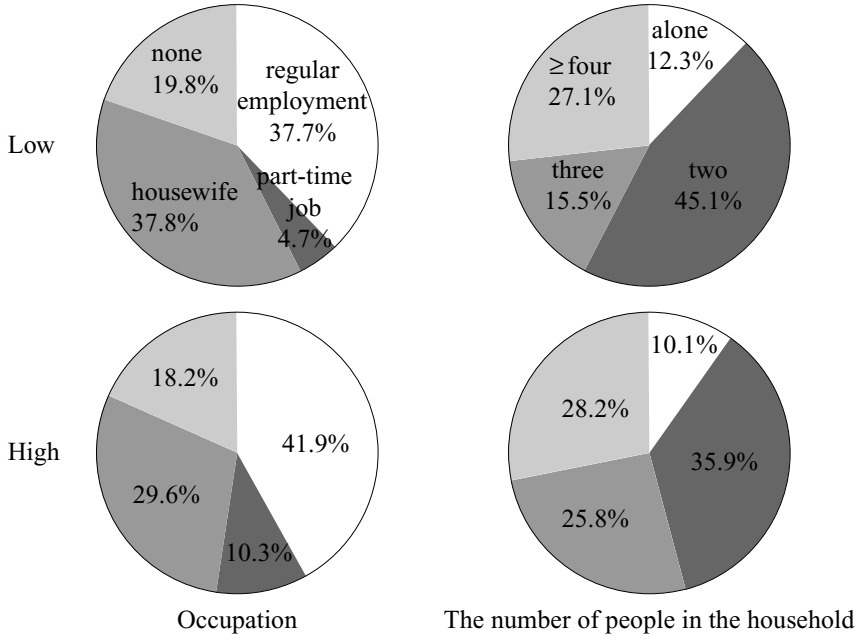

Fig. 2. *Comparison of the job status and the number of family members between patients with low and high salt excretions.*

regular employment was comparable between the groups (Fig. 2). Housewives were also similarly distributed in the two groups, and the frequency of the subjects who lived alone or with only one family member was not different between the groups (Fig. 2).

Discussion

The present study demonstrated that long-term compliance with salt restriction is poor in Japanese hypertensive patients.

JNC 7 recommends sodium reduction to a level of no more than 6 g (100 mmol of sodium)/day in hypertensive patients (*11*); however, the rate of achievement < 6 g/day of salt excretion was low in the present study. The National Nutrition Survey in Japan showed that the average salt intake was 11.4 g/day in 2002 (*12*). Salt intake in the Japanese population has been decreasing in recent years, but over the last decades it has shown a more general trend of increase along with the adoption of a more Westernized lifestyle in Japan, including such phenomena as fast food and eating out (*12*, *15–17*).

Hashimoto *et al*. reported that urinary salt excretion in a group of hypertensive outpatients did not change over a 6.4-year follow-up period (*18*). In the present study, however, urinary salt excretion at the last visit was significantly lower than that at the first visit. We have previously reported that there is no obvious reduction in the actual salt intake in salt-conscious patients (*13*). Thus, repeated monitoring of urinary salt excretion, along with providing feedback to patients and follow-up counseling, seem to be the most important and practical way to achieve a reduction of salt intake in individual hypertensives (*13*, *19*).

In the present study, we had hoped to identify specific characteristics of the subjects who are able to maintain low salt consumption. However, there were no specific differences between the Low and High salt groups. Thus, although it was expected that elderly subjects might be more conscious about salt restriction than young subjects, there was no difference in age between the groups. Similarly, although subjects who are conscious about salt restriction might also be expected to be conscious about other lifestyle modifications, including alcohol restriction, smoking cessation, and regular physical activities, there were no significant differences in these factors between the Low and High salt groups. In the case of subjects with regular employment, it might be thought that they would have more opportunities to eat out, leading to an increased salt consumption, while housewives, who usually cook by themselves, would find it easier to reduce their salt consumption. Again, however, the present observations do not support the notion of a relationship between the job status and salt consumption. Finally, the frequency of the subjects who live alone or with only one family member did not differ between the Low and High salt groups. In short, the subjects with low salt consumption could not be characterized at all.

The results of a previous study underscore the importance of public health education for the control of high BP (*6*). However, there are several barriers to the promotion of salt reduction: insufficient attention to health education by health care practitioners; lack of reimbursement for health education services; lack of access to places to engage in physical activity; larger servings of food in restaurants; lack of availability of healthy food choices in many schools, worksites, and restaurants; lack of exercise programs in schools; large amounts of sodium added to foods by the food industry and restaurants; and the higher cost of food products that are lower in salt and calories (*11*). Overcoming these barriers will require an approach directed not only to high-risk populations but also to communities, schools, worksites, and the food industry, such as informing the public about the relationship between salt intake and BP, informing the public about the importance of reading food labels to determine the salt content of common foods, reducing the salt content of existing foods while maintaining flavor, and providing low-salt flavorings for home consumption (*3*, *20*).

In conclusion, long-term compliance with salt restriction is poor in Japanese hypertensive patients. Since defining characteristics could not be identified in the salt-restricted patients, repeated measurements of urinary salt excretion seem to be important to encourage salt restriction.

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References

1. Cailar G, Ribstein J, Mimran A: Dietary sodium and target organ damage in essential hypertension. *Am J Hypertens* 2002; **15**: 222–229.
2. Antonios TFT, MacGregor GA: Salt intake: potential deleterious effects excluding blood pressure. *J Hum Hypertens* 1995; **9**: 511–515.
3. Altshul AM, Grommet JK: Food choices for lowering sodium intake. *Hypertension* 1982; **4** (Suppl): III116–III120.
4. Alli C, Avanzini F, Bettelli G, *et al*: Feasibility of a long-term low-sodium diet in mild hypertension. *J Hum Hypertens* 1992; **6**: 281–286.
5. Intersalt Cooperative Research Group: Intersalt: an international study of electrolyte excretion and blood pressure. Result for 24 hour urinary sodium and potassium excretion. *BMJ* 1988; **297**: 319–328.
6. Yamori Y, Liu L, Mu L, *et al*: Diet-related factors, educational levels and blood pressure in a Chinese population sample: findings from the Japan-China Cooperative Research Project. *Hypertens Res* 2002; **25**: 559–564.
7. Haddy FJ, Pamnani MB: Role of dietary salt in hypertension. *J Am Coll Nutr* 1995; **14**: 428–438.
8. Korhonen MH, Järvinen RMK, Sarkkinen ES, Uusitupa MIJ: Effects of a salt-restricted diet on the intake of other nutrients. *Am J Clin Nutr* 2000; **72**: 414–420.
9. Korhonen MH, Litmanen H, Rauramaa R, Väisänen SB, Niskanen L, Uusitupa MIJ: Adherence to the salt restriction diet among people with mildly elevated blood pressure. *Eur J Clin Nutr* 1999; **53**: 880–885.

10. Appel LJ, Espeland MA, Easter L, Wilson AC, Folmar S, Lacy CR: Effects of reduced sodium intake on hypertension control in older individuals. *Arch Intern Med* 2001; **161**: 685–693.
11. Chobanian AV, Bakris GL, Black HR, *et al*: Seventh report of the Joint National Committee on Prevention, Detection, Evaluation, and Treatment on High Blood Pressure. *Hypertension* 2003; **42**: 1206–1252.
12. Ministry of Health, Labour and Welfare, Japan: The National Nutrition Survey in Japan, 2002. Tokyo, Dai-ichi Shuppan Press, 2004, p. 182.
13. Ohta Y, Tsuchihashi T, Ueno M, Onaka U, Tominaga M, Eto K: Relationship between the awareness of salt restriction and the actural salt intake in hypertensive patients. *Hypertens Res* 2004; **27**: 243–246.
14. Tochikubo O, Uneda S, Kaneko Y: Simple portable device for sampling a whole day's urine and its application to hypertensive outpatients. *Hypertension* 1983; **5**: 270–274.
15. Liu L, Mizushima S, Ikeda K, *et al*: Comparative studies of diet-related factors and blood pressure among Chinese and Japanese: results from the China-Japan cooperative research of the WHO-Cardiac study. *Hypertens Res* 2000; **23**: 413–420.
16. Yoshiike N, Matsumura Y, Iwaya M, Sugiyama M, Yamaguchi M: National nutrition survey in Japan. *J Epidemiol* 1996; **6**: S189–S200.
17. Nakagawa H, Morikawa Y, Okayama A, *et al*: Trends in blood pressure and urinary sodium and potassium excretion in Japan: reinvestigation in the 8th year after the Intersalt study. *J Hum Hypertens* 1999; **13**: 735–741.
18. Hashimoto J, Imai Y, Minami N, *et al*: Compliance with long-term dietary salt restriction in hypertensive outpatients. *Clin Exp Hypertens* 1994; **16**: 729–739.
19. Miura S, Yamaguchi Y, Urata H, *et al*: Efficacy of a multicomponent program (Patient-Centered Assessment and Counseling for Exercise plus Nutrition [PACE+ Japan]) for lifestyle modification in patients with essential hypertension. *Hypertens Res* 2004; **27**: 859–864.
20. Fodor JG, Whitmore B, Leenen F, Larochelle P: Recommendations on dietary salt. *CMAJ* 1999; **160**: S29–S34.